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FORM PTO-1390 (REV 10-94)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		DOCKET #: 4925-89PUS	
<b>TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371</b>					
				U.S. APPLICATION NO. (If known, see 37 CFR 1.5) <b>09/646776</b>	
INTERNATIONAL APPLICATION NO. <b>PCT/FI99/00269</b>		INTERNATIONAL FILING DATE <b>31 March 1999</b>		PRIORITY DATE CLAIMED <b>31 March 1998</b>	
TITLE OF INVENTION <b>Delay Control Method</b>					
APPLICANT(S) FOR DO/EO/US <b>Kalle AHMAVAARA; Sami KKKI</b>					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<ol style="list-style-type: none"> <li>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371</li> <li>3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).</li> <li>4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</li> <li>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))           <ol style="list-style-type: none"> <li>a. <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).</li> <li>b. <input type="checkbox"/> has been transmitted by the International Bureau.</li> <li>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US)</li> </ol> </li> <li>6. <input type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</li> <li>7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))           <ol style="list-style-type: none"> <li>a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</li> <li>b. <input type="checkbox"/> have been transmitted by the International Bureau.</li> <li>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li>d. <input checked="" type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li>8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li>9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</li> <li>10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</li> </ol> <p><b>Items 11. to 16. Below concern other document(s) or information included:</b></p> <ol style="list-style-type: none"> <li>11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</li> <li>12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</li> <li>13. <input type="checkbox"/> A <b>FIRST</b> preliminary amendment.  <input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</li> <li>14. <input type="checkbox"/> A substitute specification.</li> <li>15. <input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li>16. <input checked="" type="checkbox"/> Other items or information (<i>specify</i>): PCT Publication Sheet, Int'l Preliminary Examination Report, Notification of Transmittal of the International Preliminary Examination Report, Written Opinion, Int'l Search Report, PCT Request, Notice Informing the Applicant of the Communication of the International Application to the Designated States, PCT Demand, Reply to Written Opinion (with amended claims)</li> </ol>					

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5) <b>09/646776</b>		INTERNATIONAL APPLICATION NO. <b>PCT/IT99/00269</b>		ATTORNEY'S DOCKET NUMBER <b>4925-89PUS</b>	
17.[x]The following fees are submitted:					
<b>Basic National Fee (37 CFR 1.492(a)(1)-(5)):</b> Search Report has been prepared by the EPO or JPO ..... <b>\$840.00</b> International preliminary examination fee paid to USPTO (37 CFR 1.482) ..... <b>\$670.00</b> No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) ..... <b>\$760.00</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... <b>\$970.00</b> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) ..... <b>\$96.00</b>					
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$	840
Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	10 - 20 =	0	x <b>\$18.00</b>	\$	
Independent Claims	3 - 3 =	0	x <b>\$78.00</b>	\$	
Multiple dependent claim(s) (if applicable)			+ <b>\$260.00</b>	\$	
TOTAL OF ABOVE CALCULATIONS =				\$	840
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				\$	
SUBTOTAL =				\$	840
Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$	840
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by the appropriate cover sheet (37 CFR 3.28, 3.31). <b>\$40.00</b> per property				\$	
				+	
TOTAL FEES ENCLOSED				\$	840
				Amount to be refunded:	\$
				charged:	\$
a. <input checked="" type="checkbox"/> One check( ) in the amount(s) of <b>\$ 840</b> and \$ to cover the above fees is/are enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. <u>03-2412</u> in the amount of \$ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>03-2412</u> . A duplicate copy of this sheet is enclosed.					
<b>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</b>					
SEND ALL CORRESPONDENCE TO: <b>Michael C. Stuart</b> Cohen, Pontani, Lieberman & Pavane 551 Fifth Avenue, Suite 1210 New York, New York 10176			 <b>Michael C. Stuart</b> Registration Number: <u>35,698</u> Tel: (212) 687-2770		

3pt

**Delay control method**

**TECHNICAL FIELD OF THE INVENTION**

- 5 The invention is directed to a method for controlling delays in a cellular telecommunications network.

**BACKGROUND OF THE INVENTION**

- 10 Modern cellular telecommunication systems comprise complicated structures of network elements. New developments, such as macro diversity combining, increase the complexity of a network. Macro diversity combining (MDC) refers to a situation, where terminal unit of a cellular telecommunication system has simultaneous connections to at least two base stations, in which case any given data
- 15 unit can be routed to the terminal unit or from the terminal unit via at least two routes. The set of such base stations is called the active set. Macro diversity - combining can be utilized especially in spread spectrum technology based systems, when the terminal unit is near the border of cells or in an area, where more than one cells overlap at least partly. One of the advantages of macro diversity combining
- 20 (MDC) is the resistance to various disturbances occurring in the propagation paths. Since fading and disturbances occurring in a given propagation path can be compensated using data transmitted via another propagation path, MDC provides a better quality of transmission than schemes based on use of single connections.
- 25 In cellular systems based on spread spectrum technology, it is advantageous to minimize the transmission power of mobile and base stations in order to maximize the capacity of the system. Macro diversity combining allows the use of lower transmitting power than in a system, where all other things being equal, the radio link between the mobile station and the network is carried by a single connection.
- 30 On the other hand, spread spectrum technology offers good possibilities to combine signal components arriving to the combination location with varying delays and power levels, due to different propagation paths or macro diversity paths. Due to these reasons, the use of macro diversity combining will increase in the future. The most common application of spread spectrum technology is the CDMA (Code
- 35 Division Multiple Access) cellular telecommunication technology.

An example of a radio network configuration providing macro diversity combining is shown in figure 1. Downlink data is transmitted from the protocol control block

- 32 in the first radio network controller (RNC) RNC1 30 to the first splitting unit 34 in the RNC1, which splitting unit replicates the downlink data stream into one stream towards a second splitting unit 34 in the RNC1, and another data stream towards the splitting unit 34 in RNC2. The second splitting unit 34 in RNC1  
5 replicates the received data stream into one stream towards a first base station (BS) 20 and another data stream towards a second base station 20. The splitting unit 34 in RNC2 further replicates the received data stream into one stream towards a third base station 20 and another data stream towards a fourth base station 20.
- 10 Uplink data from the mobile station (MS) 10 is received separately by each base station 20. The first and second base stations send the received data packets to the second combining unit 33 in RNC1, and the third and fourth base stations send the received data packets to the combining unit 33 in RNC2. When the combining units 33 have received the packets, they combine the packets and send only one packet  
15 further. The first combining unit 33 receives the output from the other two combining units, and combines the data packets, and forwards the combined data packets to the protocol control block 32.

- The combining units 33 may perform the combining in many ways. For example,  
20 the units may select only one of the two received packets and send the selected packet. They also may combine the signals of the two packets and send the combined packet.

- For clarity, the splitting 34 and combining 33 units are represented by a single  
25 symbol in figure 1.

- In such a configuration, problems are caused by the fact that each downlink packet has to be sent from each BS towards the MS at roughly the same time or within a small time window, while the delay from the RNC to base stations varies. The delay  
30 variation may be caused by numerous reasons. For example, physical distance and transmission links between base stations and the radio network controller changes when the base station (BS) or base stations used by a mobile station (MS) is/are changed. Further, each part of the chain of transmission links can have different properties such as bitrate and characteristic delay variation, which properties may  
35 change due to variations in traffic or for other reasons. Delays are in turn caused for example by the physical length of the transmission links, and processing of the transmitted data in the network entities. Such processing can for example be encoding, splitting, or combining of data packets. A further problem in downlink

direction is, how to keep the difference between the sending time of packets from RNC and transmission time of the packets by the base stations in minimum, while still fulfilling the edge condition, that each BS receives the data before it has to be transmitted.

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In the uplink direction, a problem is how to determine the combining time for each combining/splitting unit, while still fulfilling the edge condition that the combined data packet is to be received by the protocol control block by the defined time. The combining time is the point in time, by which a combining unit must send the combined data to its output, regardless of whether all packets to be combined are received or not.

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An additional problem, which is not solved by the prior art structures, is how to take advantage of statistical multiplexing gains resulting of multiplexing of transmission links, since the more efficiently the data is multiplexed, the longer the average delay is and especially, the longer the delay variation is. Statistical multiplexing gains refer to savings in the use of data transmission resources obtained, when the data packet transmission times and other transmission parameters of bearers having relatively loose delay requirements are adjusted in order to accommodate data packets of bearers having stricter delay requirements.

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The prior art solutions do not address all of the previous problems. One prior art solution is used in the GSM system, where in the downlink direction, a base station can indicate to a transcoder unit, that the transcoder unit has to advance the transmission times of frames sent towards the base station. This mechanism is explained in detail in the specification GSM 08.60.

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## SUMMARY OF THE INVENTION

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The object of the invention is to realize a delay control method for allowing more accurate control of delays than in the prior art systems. A further object of the invention is to realize a delay control method, which allows a modular network structure to be used in the implementation of the method.

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The objects are reached by performing the delay control in a hierarchical way using a tree-like delay adjustment hierarchy, where each node of the tree adjusts the delay of its branches.

The method for delay control adjustment in the uplink direction according to the invention is characterized by that, which is specified in the characterizing part of the independent method claim directed to a method for delay control adjustment in the uplink direction. The method for delay control adjustment in the downlink direction according to the invention is characterized by that, which is specified in the characterizing part of the independent method claim directed to a method for delay control adjustment in the downlink direction. The system according to the invention is characterized by that, which is specified in the characterizing part of the independent method claim directed to a system. The dependent claims describe further advantageous embodiments of the invention.

The delay control method according to the invention is based on a hierarchical structure of delay controlling entities, which preferably communicate only with entities directly above or below them in the hierarchy. In the downlink direction, an entity receiving data, such as a base station or a splitting unit, sends a timing report to the entity sending the data if the data is received too early or too late (outside a predefined time period), whereafter the sending entity may adjust the sending time of data. The same reporting and adjusting process may be repeated through all levels of the control hierarchy, resulting in a collective control of delays from the top of the hierarchy, for example from a RNC, to the bottom, for example to a base station.

In the uplink direction, a higher level entity receiving data from a lower level entity may command the lower level entity to adjust the sending time, if the data is received too early or too late. When the same action is repeated in all levels of the hierarchy, a collective control of delays is achieved for the link between the lowest level, e.g. the base station, and the highest level, e.g. a RNC.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in more detail in the following with reference to the accompanying drawings, of which

Figure 1 illustrates a hierarchical network structure according to prior art,

Figure 2 illustrates an example of messaging according to an advantageous embodiment of the invention, and

Figure 3 illustrates an example of messaging according to an advantageous embodiment of the invention.

Same reference numerals are used for similar entities in the figures.

## DETAILED DESCRIPTION

### Adjustment of delays in the downlink direction

- 10 In the downlink direction, the delays are adjusted as follows according to an advantageous embodiment of the invention. If an entity, herein called the receiving entity, receives packets too late for one or more bearers, or if packets are received too early, before a certain predefined point in time, the receiving entity informs the entity preceding it in the downlink direction in the transmission path about the
- 15 inaccurate timing. As a response, the preceding entity adjusts the transmission time of the packets to bring the arrival time of the packets to the receiving entity closer to the desired arrival time. In case the preceding entity cannot send the packets earlier due to the arrival time of packets to the preceding entity, the preceding entity may also inform the entity before it in the downlink direction of the transmission path,
- 20 that the packets are received too early. Preferably, this mechanism of informing and adjustment is executed at each entity below the radio network controller in a downlink transmission path, thus forming a chain of delay controlling nodes from the RNC to each base station controlled by the RNC. In an advantageous embodiment of the invention, the base stations are the lowest level entities which
- 25 send timing reports, and the controlling, i.e. the anchor RNC is the highest level entity reacting to the timing reports.

- The invention is not limited to such an embodiment, where all entities between the RNC and a base station participate in the delay control. In some embodiments of the
- 30 invention, at least one of the intermediate entities such as splitting units between the RNC and a base station does not perform delay controlling. For example, in such an embodiment, the base stations may send a report of the packet arrival times, which report is merely sent further by the entities between the base station and the protocol control block of the RNC, and which report is finally received by the protocol
- 35 control block, which subsequently adjusts the transmission time of downlink data packets.

In one advantageous embodiment of the invention, the transmission time of downlink data packets from an entity is determined by the link having longest delay estimate, i.e. by the latest reported arrival time.

- 5 In some embodiments of the invention, the receiving entity may inform the preceding entity about the timing repeatedly, with predetermined intervals, even if packets are not received too late or too early. The preceding entity then only reacts to the report, if the timing deviates too much from the desired optimum timing.
- 10 In an advantageous embodiment of the invention, the delay can be controlled separately for each bearer or commonly for all bearers for a mobile station. Delay control of all bearers allows simple adjustment of all bearers for example in a situation, when the transmission link configuration changes e.g. due to a handover, which usually affects all bearers of a mobile station in substantially similar way.
- 15 Each splitting unit causes also processing delay, and since the number of splitting units in a transmission path can vary when the transmission link configuration changes, the delay between a base station and the radio network controller can change stepwise for all bearers of a mobile station passing through a single base station. On the other hand, delay control of single bearers allows producing of
- 20 different delays for different bearers, which in turn allows more efficient multiplexing of transmission links for bearers having less strict delay requirements. In a further embodiment of the invention, the delay can be controlled for a group of bearers as well. Therefore, a timing report may comprise identification and timing data for a single bearer, identification and timing data for multiple bearers, or
- 25 identification and timing data for all bearers of a mobile station. For example, in terms of one set of specifications for an UMTS cellular system, a timing report may be specific to a certain RLC protocol, or a group of RLC protocols, or specific to a MAC protocol.
- 30 Figure 2 illustrates an example of messaging in an exemplary embodiment of the invention. Figure 2 illustrates the exchange of messages between a base station (BS) 20, a combining unit (CU) 33 and a protocol control block (PCB) 32 of a radio network controller. First, the protocol control block sends 200 one or more data packets to the combining unit. The combining unit forwards 210 the data packets to
- 35 the base station. In this example, the data packets arrive too late to the base station, which subsequently notices 220 the late arrival. As a response, the base station sends 230 a timing adjustment request TIME\_ADJ\_REQ to the combining unit. The combining unit checks, if it can send the data earlier. In this example it can, and the



combining unit subsequently changes 250 the sending time to an earlier time. After the change, the data transfer continues as usual, i.e. the protocol control block sends 260 one or more data packets to the combining unit, which forwards 270 the data packets to the base station. The data transmission continues, until at a later time in  
5 this example, the network configuration changes in a way, which results in an increased delay between the combining unit 33 and the protocol control block 32. Subsequently, when the protocol control block sends 280 one or more data packets to the combining unit, the combining unit notices 290, that the data packets arrive too late for the combining unit to send them to the base station. As a response, the  
10 combining unit sends 300 a timing adjustment request TIME\_ADJ\_REQ to the protocol control block. Due to the request, the protocol control block changes 310 the sending time in use. After the change, the data transfer continues as usual, i.e. the protocol control block sends 320 one or more data packets to the combining unit, which forwards 330 the data packets to the base station.

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#### **Adjustment of delays in the uplink direction**

Each entity in the transmission path, such as a combining unit, may inform the entity preceding it in the uplink direction in the transmission path, if data packets  
20 from the preceding entity arrive too late or too early. Each entity may further indicate, how much the arrival time of packets deviate from the desired optimum time. The preceding entity may consequently change the transmission time of data to correct the deviation. The entity receiving the data may also command the preceding entity to send the data at a specified time. For example, the receiving  
25 entity may command the preceding entity to adjust the data sending time a certain amount of time earlier. In the case of combining units, the data sending time may be the combining time.

If the preceding entity itself receives data so late, that it cannot send the data any  
30 earlier, it may in turn command the entity or the entities preceding it to send data earlier. In this way, the delay is recursively adjusted in the chain- or tree-like structure formed by the entities from end to end.

In some situations, the data sending time of an entity cannot be changed to an earlier  
35 time. For example, if a base station sends the received data in the uplink direction as soon as possible, and any eventual intermediate entities such as combining units along the path also send the data as soon as possible, the sending time of the base station or any of these intermediate entities cannot be changed to an earlier time. In

such a case, the base station or base stations in question may be excluded from the active set.

5 In an advantageous embodiment of the invention, each entity may instead of sending a transmission time changing command to a preceding entity, enhance the transmission link between itself and the preceding entity in order to reduce delay. The transmission link may be enhanced for example by allocating more transmission time for the delayed connection. Other methods for increasing the data throughput rate of a connection may be used as well.

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Preferably, the entity at the root of the delay control hierarchy, such as the controlling RNC, gives as much time for the entities preceding it in the uplink direction of the delay control hierarchy, i.e. by setting the desired arrival time of uplink data as late as the delay specifications of the involved bearer or bearers allow. Preferably, one or more of the intermediate entities in the transmission path between the controlling RNC and base stations also allow as much time as possible for the other entities preceding the entity in question.

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20 In an advantageous embodiment of the invention, the delay can be controlled separately for each bearer or commonly for all bearers for a mobile station. Delay control of all bearers allows simple adjustment of all bearers for example in a situation, when the transmission link configuration changes e.g. due to a handover, which usually affects all bearers of a mobile station in substantially similar way. Each combining unit causes also processing delay, and since the number of  
25 combining units in a transmission path can vary when the transmission link configuration changes, the delay between a base station and the radio network controller can change stepwise for all bearers of a mobile station passing through a single base station. On the other hand, delay control of single bearers allows producing of different delays for different bearers, which in turn allows more  
30 efficient multiplexing of transmission links for bearers having less strict delay requirements. In a further embodiment of the invention, the delay can be controlled for a group of bearers as well. Therefore, a timing adjustment command may comprise identification and timing data for a single bearer, identification and timing data for multiple bearers, or identification and timing data for all bearers of a mobile  
35 station. For example, in terms of one set of specifications for an UMTS cellular system, a timing adjustment command may be specific to a certain RLC protocol, or a group of RLC protocols, or specific to a MAC protocol.

Figure 3 illustrates an example of messaging in an exemplary embodiment of the invention. Figure 3 illustrates the exchange of messages between a base station (BS) 20, a combining unit (CU) 33 and a protocol control block (PCB) 32 of a radio network controller. First, the base station sends 100 one or more data packets to the combining unit. The combining unit forwards 110 the data packets to the protocol control block. In this example, the data packets arrive too late to the protocol control block, which subsequently notices 120 the late arrival. As a response, the protocol control block sends 130 a timing adjustment command TIME\_ADJ\_CMD to the combining unit. The combining unit checks 140, if it can change the combining time to an earlier time. In this example, the combining unit receives packets from the base station so late, that the combining unit cannot send the packets earlier, if the base station does not change its sending time. Subsequently the combining unit sends 150 a timing adjustment command TIME\_ADJ\_CMD to the base station. In this example, the base station can change its sending time to an earlier time, and subsequently makes 160 the change. After changing the sending time, the base station continues sending 170 data to the combining unit, which forwards 180 the data to the protocol control block.

#### **Further advantageous embodiments of the invention**

The method according to the invention can advantageously implemented in a network structure, whose transmission links are implemented using technology, which allows the parameters of a connection to be adjusted. Although the method according to the invention is advantageously implemented in transmission networks having adjustable transmission links, the method according to the invention can also be used in cases, when one or more of the transmission links are not adjustable. For example, if a data transmission link between a first combining unit receiving data from a second combining unit and the second combining unit is not adjustable, the delay control may be performed in the previously described way by treating the first and second combining units as a single unit. This may be realized for example by treating the inputs of the second combining unit as inputs of the first unit, and treating the delay created by the processing in the second combining unit and by the non-adjustable link as internal processing delays of the first combining unit. This structure may require special messaging between entities controlling the first and second combining units, or for example the creation of a single entity controlling both the first and the second combining unit.

The delay control method according to the invention is not dependent on what entities execute the method. Although the previous examples describe the delay control method using combining units and the protocol control blocks of a RNC as examples, any other entity in the transmission path can participate in the implementation of the method.

The delay control method according to the invention has many advantages. For example, since the delay control can be performed as a chain of independently controlling entities, the implementation of the delay control in a complicated network is simplified, since each controlling entity does not need to know the details of the structure it is controlling. Each controlling entity simply communicates with a lower-level entity, which in turn takes care of controlling entities in the following lower level. This property simplifies the construction of a network using equipment from multiple vendors, since the controlling entity does not need to know how a certain adjustment is implemented in a proprietary internal structure of the controlled entity and the possible proprietary structure of the entities managed by the controlled entity.

In different embodiments of the invention, the number of various entities, such as for example splitting units, combining units, base stations, and radio network controllers may be different, and differ from the number of corresponding entities in any of the examples and figures of this specification. The entities may also be realised and combined in differing ways, for example, one radio network controller can comprise one or more combining units and splitting units. Therefore, the messaging and functionality described by the previous examples can be performed between a radio network controller and a base station, i.e. across the Iub interface, and for example also between two radio network controllers, i.e. across the Iur interface.

The name of a given functional entity, such as the radio network controller, is often different in the context of different cellular telecommunication systems. For example, in the GSM system the functional entity corresponding to a RNC is the base station controller (BSC). Therefore, the term radio network controller in the claims is intended to cover all corresponding functional entities regardless of the term used for the entity in the particular cellular telecommunication system.

In the previous examples, the various entities such as combining units were described as integral entities performing all of the duties of the entity, e.g.

combining of packets, and necessary adjustments, e.g. changing the transmission rate of a transmission link. In some embodiments of the invention, such entities may comprise one or more functional blocks, such as e.g. a block performing the combining of packets and a block performing the control of transmission links. As a  
 5 man skilled in the art knows, such entities can be constructed in many ways. Therefore, the description of entities as integral entities in the previous examples is intended to be only an example. Such description is used in this specification for the purposes of clarity only.

10 Although in the previous examples, the delay control method according to the invention has been described using a tree structure formed by the entities of the telecommunications network, the invention is not limited to implementation in a tree structure. The method for uplink and downlink delay control according to the invention can also be used in a chain structure.

15 In the following claims, the term node is used for the various previously described entities, such as the combining and splitting units, radio network controllers and base stations. In the following claims, the terms preceding and following are to be interpreted in view of the data flow to the specified direction. As an example, a  
 20 radio network controller precedes a base station in the downlink direction, since in the downlink direction, data packets pass first through a radio network controller, and only after that through a base station. Similarly, a base station precedes a radio network controller in the uplink direction, since in the uplink direction, data packets pass first through a base station, and only after that through a radio network  
 25 controller. Further, the term intermediate node refers to an entity in the transmission path between the protocol control block of a radio network controller and a base station. Such an intermediate node may be for example single unit or a group of units performing the duties of a splitting unit and a combining unit.

30 In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. While a preferred embodiment of the invention has been described in detail, it should be apparent that many modifications and variations thereto are possible.

## Claims

1. A method for delay control adjustment in the uplink direction in a cellular telecommunications network comprising a plurality of functionally interconnected nodes for transmission of data, **characterized in that**
- 5 at least one first node sends (130) a timing adjustment command to at least one second node, if at least one uplink data packet sent by said at least one second node arrives at said at least one first node at a point in time, which point in time is outside a predefined time period, and
- 10 at least one node functions as said at least one first node in view of at least one node preceding it in the uplink direction in the network structure, and as said at least one second node in view of at least one node following it in the uplink direction in the network structure.
- 15 2. A method according to claim 1, **characterized in that** at least one of said at least one second node is a base station (20).
3. A method according to claim 1, **characterized in that** at least one of said at least one first node is a protocol control block (32) of a radio network controller.
- 20 4. A method according to claim 1, **characterized in that** at least one of said nodes is a combining unit (33).
5. A method for delay control adjustment in the downlink direction in a cellular telecommunications network comprising a plurality of functionally interconnected nodes for transmission of data, **characterized in that**
- 25 at least one second node sends (230) a timing adjustment request to at least one first node, if at least one downlink data packet sent by said at least one first node arrives at said at least one second node at a point in time, which point in time is outside a predefined time period, and
- 30 at least one node functions as said at least one second node in view of at least one node preceding it in the downlink direction in the network structure, and as said at least one first node in view of at least one node following it in the downlink direction in the network structure.
- 35 6. A method according to claim 5, **characterized in that** at least one of said at least one second node is a base station (20).

7. A method according to claim 5, **characterized** in that at least one of said at least one first node is a protocol control block (32) of a radio network controller.

8. A method according to claim 5, **characterized** in that at least one of said  
5 nodes is a splitting unit (33).

9. A system in a cellular telecommunications network for controlling delays between a radio network controller and at least one base station, **characterized** in that

10 the system comprises

- a radio network controller for controlling the transfer of data,  
- at least one intermediate node (33) for forwarding data in the network, which at least one intermediate node is functionally connected to said radio network controller, and

15 - a base station (20) for sending and receiving data, which base station is functionally connected to said at least one intermediate node, and in that,

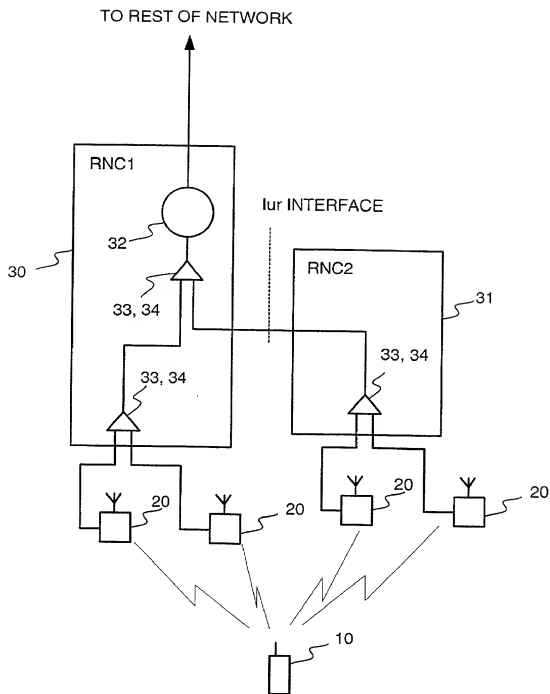
- said radio network controller is arranged to send a timing adjustment command to at least one of said at least one intermediate node as a response to reception of at least one data packet from said at least one of said at least one intermediate node after a predetermined time period,

20 - and said at least one intermediate node is arranged to send a timing adjustment command to said base station as a response to reception of at least one data packet from said base station after a predetermined time period.

25

10. A system according to claim 9, **characterized** in that

said base station (20) is arranged to send a timing adjustment request to at least one of said at least one intermediate node (33) as a response to reception of at least one data packet from said at least one of said at least one intermediate node after a  
30 predetermined time period.

**Fig. 1**

PRIOR ART



2 / 3

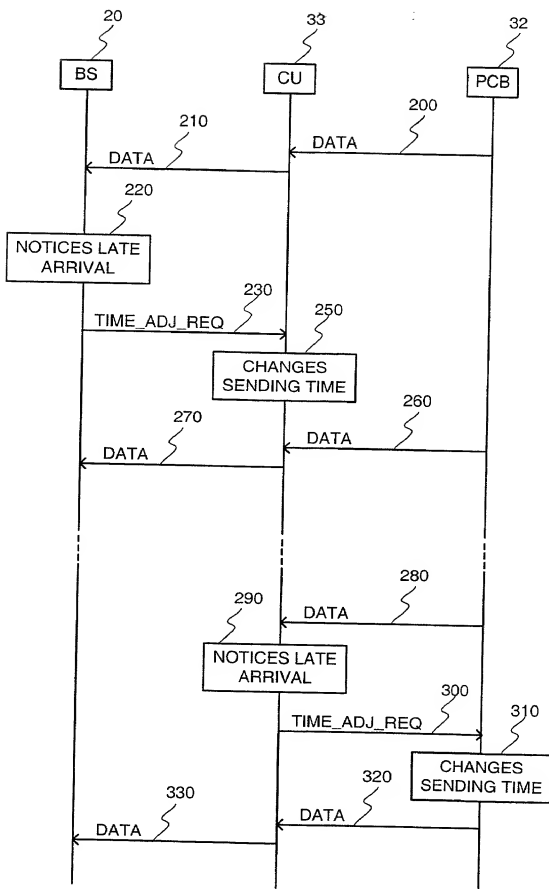


Fig. 2

3 / 3

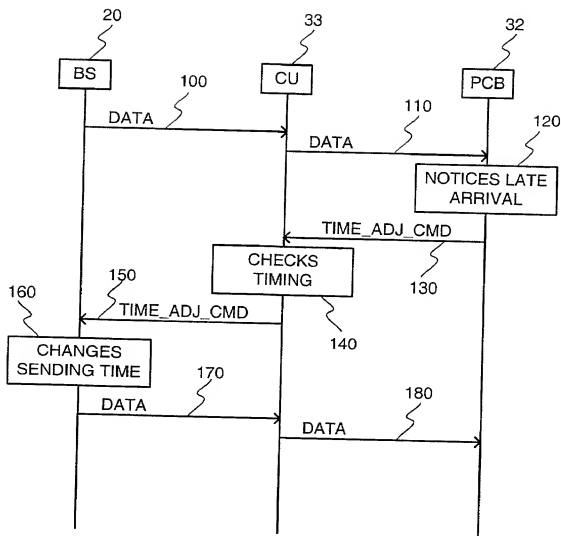


Fig. 3

Attorney's Docket  
No. 4925-89PUS

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

## A METHOD FOR CONTROLLING CONNECTIONS TO A MOBILE STATION

the specification of which (check only one item below)

☐ is attached hereto

□ was filed as United States application

Serial No. \_\_\_\_\_

OD

and was amended

on (if applicable).

[x] was filed as PCT international application

Number PCT/FI99/00269

on 31 March 1999

and was amended under PCT Article 19

on (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of the application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

**PRIOR FOREIGN/PCT APPLICATIONS AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:**

[illegible]

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS (check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.				
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)		
PCT/199/00269	31 March 1999			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute the application and transact all business in the Patent and Trademark Office connected therewith (List name and registration number)

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17

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201 <i>[Signature]</i>	SIGNATURE OF INVENTOR 202 <i>[Signature]</i>	SIGNATURE OF INVENTOR 203
DATE 20/10/2000	DATE 27/10/2000	DATE

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